Vascular flora and historic vegetation of the Washita Battlefield National Historic Site, Roger Mills County, Oklahoma: Final Report

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ABSTRACT

The objectives of this research were to inventory the vascular plants of the Washita Battlefield National Historic Site and analyze vegetation patterns circa 1871. The floristic inventory yielded 272 species of vascular plants collected from 201 genera and 62 families. The most specious families were the Poaceae (53 species), Asteraceae (48 species), and Fabaceae (22 species). One hundred and seventy-five perennials 95 five annuals, and two biennials were present, as well as 28 species of woody plants. Twenty-one species exotic to North America were collected, representing 7.7% of the flora. Five species tracked by the Oklahoma Natural Heritage Inventory were found. This study reports 205 species previously not documented in Roger Mills County. Vegetation in 1871 consisted of grasslands (316.7 acres) and riparian areas (18.7 acres). No settlements or cultivated fields were present in 1871. Surveyor's recorded two cottonwood trees along the Washita River measuring 24 and 18 inches. Data were not available for 1897.

INTRODUCTION

Floristic Inventories

Floristic inventories continue to be valuable tools for research, conservation, and management (Palmer et. al 1995). For example, it has been recently documented that new taxa are discovered and described at a rate of 60 per year (Ertter 2000). Prior to 2002, when collecting began for this study, 446 specific and intraspecific taxa were reported from Roger Mills County (Hoagland 2004). *Erigeron bellidiastrum* Nutt.

(western daisy fleabane; Asteraceae), collected by J. Engleman on 3 July 1919, was the first botanical specimen gathered in Roger Mills County. There are no subsequent collection records until 1929. Peak collecting years in Roger Mills County were 1939 (261 specimens), with the return of J. Engleman, and 1976 by Susan Barber and Rahmona Thompson (124 specimens) on behalf of the Robert Bebb Herbarium at the University of Oklahoma (Hoagland 2004). During the course of this research, Freeman et al. (2002) published a floristic list from the Thurman Ranch in Roger Mills County, located south of Washita Battlefield National Historic Site (WBNHS), which documented 470 species from 85 families.

Historical Vegetation

A number of techniques and data sources are available for the study of historical vegetation composition and structure. One is the analysis of written accounts prepared by early explorers and tourists. Although partial lists of species encountered, often with questionable accuracy regarding species identification, and vague descriptions of vegetation are provided, this information is insufficient for quantitative analysis of species composition and abundance. The most useful historical data source for analysis of landscape structure and vegetation composition are the notes and plats compiled by General Land Office (GLO) surveyors. The first land surveys of what would become Oklahoma were initiated in 1871 with establishment of the Initial Point in Murray County. However, only the western 2/3's of the state was surveyed at this time. It wasn't until the early 1890's the entire state was surveyed.

OBJECTIVES

The objectives of this study were two fold. The first was to provide a comprehensive floristic inventory for resource managers at the Washita Battlefield National Historic Site (WBNHS). Such inventories aid managers in locating populations of sensitive species and documenting the occurrence of exotic and nuisance species (Barkley 2000). Ignorance of the presence of exotic species can be detrimental to sensitive species and/or exert adverse economic impacts (Ertter 2000). The second objective was to provide historic landcover data as an aid in evaluating landcover change.

STUDY AREA

The WBNHS was established on 12 November 1996 and encompasses 136 hectares in Roger Mills County (Fig. 1). Latitudinal extent ranges from 35.63^{o}N to 35.62^{o}N and longitudinal extent from 99.70^{o}W to 99.71^{o}W. The WBNHS is located within the subtropical humid (Cf) climate zone (Trewartha 1968). Summers are warm (mean July temperature = 27.7^{o}C) and humid, whereas winters are relatively short and mild (mean January temperature = 1.9^{o}C). Mean annual precipitation is 105.6 cm, with periodic severe droughts (Oklahoma Climatological Survey 2004). Physiographically, the study area is located in the Osage Plains section of the Central Lowlands province (Hunt 1974) and within the High Plains province of Oklahoma (Curtis & Ham 1979). Elevation in the study area ranges from 588 m along the Washita River to 610 m. The

surface geology is primarily Permian red sandstone in the uplands to the south of the Washita River, and Quaternary silt, sand, and clay adjacent to and north of the river (Branson & Johnson 1979). The primary soil association at WBNHS is the Yahola-Port, which is composed of alluvial soils on bottomlands and terraces. The Woodward-Quinlan association occurs on uplands and is level to very steep loamy soils underlain by red sandstone (Burgess et al. 1959). The predominant potential vegetation types are mixedgrass prairie with a smaller component of bottomland forests and stabilized dunes (Duck & Fletcher 1943). Much of the Washita River bottomlands were cleared for agriculture and pasturage.

METHODS

Floristic Inventory

Eight collection sites were established at WBNHS for intensive floristic sampling (Fig 1). Sites were selected following a review of US Geological Survey 1:24,000 topographic maps and field reconnaissance. Collection sites were selected to represent the widest possible range of habitat types present at WBNHS. Transects or plots are not used for this type of sampling. However, collecting was not restricted to these sites and previously uncollected species were gathered wherever they were encountered.

The predominant vegetation association at these sites was classified according to Hoagland (2000). Collections were made on a monthly basis from March through

October 2002. Vouchers of species introduced to North America were made from naturalized populations only, thus excluding cultivated and ornamental plants. Specimens were processed at the Robert Bebb Herbarium of the University of Oklahoma (OKL) following standard herbarium techniques. Manuals used for specimen identification included Correll and Johnston (1970), Gould (1975), Waterfall (1969), and Great Plains Flora Association (1986). Origin, whether native or introduced to North America, was determined using Taylor and Taylor (1991) and the United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS 2004). Nomenclature follows USDA-NRCS (2004). Voucher specimens were deposited at OKL.

Historical Vegetation

Analyses were conducted to ascertain the spatial distribution of land cover types at WBNHS. In order to do so, the 1871 township plat containing WBNHS was digitized using ArcInfo GIS. Plats were obtained from the Archives branch of the Oklahoma Department of Libraries (ODL) in Oklahoma City. During this research, it was discovered that the plat for 1897 was missing from ODL and no longer available, and thus excluded from analysis. All information digitized from the 1871 plat was attributed to one of the following categories: vegetation (forests, grassland, and wetlands), hydrology (streams, rivers, springs, and ponds), agriculture (cultivated fields), transportation (roads, trails, and railroads), and settlement (residences, schools, and other cultural features).

FRAGSTATS (McGarigal and Marks 1994), a landscape ecology software package, was used to determine landscape composition, defined here as the number of occurrences and area occupied by each land cover type. FRAGSTATS indices used in this study were class area, number of patches, and mean patch size. Number of patches is a measure of individual occurrences of a given land cover type. Mean patch size is an average of the area occupied by all patches of a land cover type (McGarigal and Marks 1994).

RESULTS AND DISCUSSION

Floristic Inventory

A total of 272 vascular plants in 201 genera and 62 families were collected (Table 1, Appendix 1). Among the angiosperms, 67 were monocots and 204 were dicots. One gymnosperm was found. The most species were collected from the families Poaceae (53), Asteraceae (48), Fabaceae (22), and Euphorbiaceae (14). The genera *Chamaesyce* (Euphorbiaceae, 5), *Eragrostis* (Poaceae, 4), *Dalea* (Fabaceae, 4), and *Solanum* (Solanaceae, 4) had the most species. Twenty-eight woody plant species were present. Ninety-five species were annual, two biennials, and 175 perennial.

Twenty-one exotic species from 14 families were collected, representing 7.7% of the flora. This is a lower percentage than reported for other floristic studies in Oklahoma. For example, Freeman et al. (2003) reported that 10% of the flora at Thurman Ranch consisted of introduced species. At the Chickasaw National

Recreation Area 12% of the flora consisted of exotic species (Hoagland & Johnson 2001). The percentage of exotic species in the floras of Oologah Wildlife Management Area (Hoagland & Wallick 2003), 15% at Keystone Wildlife Management Area (Hoagland and Buthod 2003), and 11% for an inventory of Tillman County (Hoagland et al., 2004) were 9%, 15%, and 11%, respectively. Red Slough and Grassy Slough, in southeastern Oklahoma, had a lower of exotic species (6.6%) (Hoagland & Johnson 2004) than at WBNHS.

The majority of exotic species at WBNHS are not a threat to the biodiversity or management of the site. Some, such as *Arenaria serpyllifolia* (thymeleaf sandwort; Caryophyllaceae), *Capsella bursa-pastoris* (shepherd's purse; Brassicaceae), *Stellaria media* (common chickweed; Caryophyllaceae), and *Taraxacum officinale* (dandelion; Asteraceae) are common lawn weeds. Others, including *Chenopodium album* (lambsquarter; Chenopodiaceae), *Convolvulus arvensis* (field vineweed; Convolvululaceae), and *Tragopogon dubius* (yellow salsify, Asteraceae) are restricted to disturbed areas. The most aggressive weedy species present at WBNHS are *Kochia scoparia* (kochia; Chenopodiaceae), *Sorghum halepense* (Johnsongrass; Poaceae), and *Tamarix ramosissima* (saltcedar; Tamaricaceae). Abundance of the later two species should be carefully monitored. As old-field disturbed areas are restored to native vegetation, the abundance of *K. scoparia* will decline, although it may be present in the soil seed bank for a number of years.

Five species tracked by the Oklahoma Natural Heritage Inventory were found: *Argythamnia humilis* (low silverbush; Euphorbiaceae; G5S2S3), *Gaura brachycarpa*

(plains beeblossom; Onagracaceae; G4G5 S1S2), *Solanum triflorum* (cutleaf nightshade; Solanaceae; G5S1S2), *Sporobolus giganteus* (giant dropseed; Poaceae; G5S1S3), and *Zinnia grandiflora* (prairie zinnina; Asteraceae; G5S?) (Oklahoma Natural Heritage Inventory 2004). Species are ranked according to level of imperilment at the state (S) and global (G) levels on a scale of 1-5; 1 represents a species that is imperiled and 5 one that is secure (Groves et. al, 1995). None of these species are listed as threatened or endangered by the U.S. Fish and Wildlife Service. Furthermore, although considered rare in Oklahoma, these species are more common in adjoining states.

A total of 651 species are now known to occur in Roger Mills County when the results of this study are added to the species previously known to occur in the county. Of the 272 species reported at WBNHS, 156 species collected at WBNHS had been previously recorded in the county (Hoagland 2004), whereas 116 species collected at the site had not been previously reported. A comparison with the Thurmond Ranch flora (Freeman et al. 2002) reveals 219 species in common with WBNHS. Fifty-three species were collected at WBNHS that were not reported at Thurmond Ranch. However, 251 species were found at the Thurmond Ranch that were not present at the WBNHS. This discrepancy is a product of greater size (3,755 hecatres) and habitat complex (19 vegetation types) at the Thurman Ranch (Freeman et al. 2002).

We believe that this floristic list represents 90% of the plants present at WBNHS. However, an exact determination is not possible. The WBNHS list could be compared with a Roger Mills County listed generated by Hoagland (2004) or Freeman et al.(2002),

but this would not provide an accurate assessment, due to the difference in total area and habitat complexity.

The 8 collection sites at WBNHS occurred within three vegetation associations. A brief description of each follows:

Sapindus saponaria woodland association

This association was limited to large sand dunes located on the northside of the Washita River. Although *S. saponaria* (soapberry; Sapindaceae) was abundant, dominance was locally variable. *Ulmus pumila* (Siberian elm; Ulmaceae) , which was introduced to western Oklahoma for shelterbelt plantings, was also a woody species. Other common woody species included *Celtis laevigata* var. *reticulata* (netleaf hackberry; Ulmaceae), *Forestiera pubescens* (elbowbush; Oleaceae), *Gymnocladus dioicus* (Kentucky coffee-tree; Fabaceae), *Prunus angustifolia* (sand plum; Rosaceae), *Ribes aureum* (golden currant; Grossulariaceae), and *Sideroxylon lanuginosum* (gumbully; Sapotaceae). Associated herbaceous species included *Andropogon hallii* (sand bluestem; Poacae), *Argemone polyanthemos* (prickly poppy; Papavaraceae), *Asclepias arenaria* (sand milkweed; Asclepiadaceae), *Cyclanthera dissecta* (winged pigweed; Chenopodiaceae), *Dimorphocarpa candicans (*Palmer's spectacle pod; Brassicaceae), *Froelichia gracilis* (slender snakeroot; Amaranthaceae), and *Funastrum cynanchoides* (fringed twinevine; Asclepiadaceae).

Schizachyrium scoparium-Bouteloua hirsuta herbaceous association

This association occurred on Permian red sandstone overlain by the Woodward-Quinlan soil association in the uplands. Associated species included *Aristida oligantha* (prairie threeawn; Poaceae), *Artemisia psiolstachya* (western ragweed; Asteraceae), *Bouteloua curtipendula* (sideoats grama; Poaceae), *Eriogonum annuum* (annual buckwheat; Polygonaceae), *Penstemon albidus* (white penstemon; Scrophulariaceae), *Sphaeralcea coccinea* (scarlet globemallow; Malvaceae), *Thelesperma megapotamicum* (greenthread; Asteraceae), *and Yucca glauca* (soapweed; Agavaceae).

Disturbed areas and old-field vegetation

This included much of the Washita River floodplain, which had been under cultivation for many years. It also included roadsides and areas visited by WBNHS visitors and other areas exhibiting signs of physical disruption. Common plants in disturbed areas and old fields included *Ambrosia trifida* (giant ragweed; Asteraceae), *Bothriochloa ischaemum (*old world bluestem*;* Poaceae), *Chenopodium simplex (*mapleleaf goosefoot; Chenopodiaceae), *Cynodon dactylon* (Bermudagrass; Poaceae), *Digitaria ciliaris* (southern crabgrass; Poaceae), *Melilotus officinalis* (yellow sweetclover; Fabaceae), and *Sorghum halepense* (Johnsongrass; Poaceae).

Historical vegetation

Only two land cover types occurred within the boundaries of WBNHS (Fig. 2).

Riparian areas covered 18.7 acres and grasslands 316.7 acres. No settlements or cultivated fields were present in 1871. Although the surveyors noted the battle had occurred in this area, a precise location was not mapped.

General Land Office survey recorded two cottonwood trees growing along the Washita River (Appendix 2). Although the surveyors did not collect specimens from these trees, they were most likely eastern cottonwoods (*Populus deltoides*). In the written description of the river, surveyors list coffee tree, elm, and hackberry as present, but did not provide diameter or distance measurements. Given the low number of trees recorded by surveyors, it was deemed spurious to attempt calculations of dominance or density.

Because the plat and survey notes from 1897 were not available from ODL, an analysis of land cover change was not possible. However, some observations can be made regarding the historic and contemporary landscape. Before making such comparisons, it is important to note that surveyor's did not comment on the herbaceous flora and vegetation. Thus, the grasslands were only mapped as such, with no notation indicating dominant species. We will never know if little bluestem and hairy grama were the dominant species at the time of the surveys, nor will we ever know the total number of woody or herbaceous species encountered by surveyors.

The surveyors did not record the occurrence of disturbed areas and old fields such as noted in the current floristic inventory, as these are products of late 19th and 20th century cultivation. Of course, some of the native species indicative of disturbance were certainly present at the WBNHS at the time of the surveys because of grazing by

large native herbivores, the actions of fossorial animals, and the dynamics of the Washita River channel. Among this group of plants are *Amaranthus albus* (prostrate pigweed; Amaranthaceae), *A. palmeri* (carelessweed; Amaranthaceae), *Chaerophyllum tainturieri* (hairyfruit chervil; Apiaceae), *Ambrosia trifida* (gaint ragweed; Asterace), *Amphiachyris dracunculoides* (broomweed; Asteraceae), *Cirsium vulgare* (bull thistle; Asteraceae), *Conyza canadensis* (horseweed; Asteraceae), *Helianthus annuus* (annual sunflower; Asteraceae), *Xanthium strumarium* (cocklebur; Asteraceae), *Mollugo verticillata* (green carpetweed; Molluginaceae), *Chamaesaracha conioides* (gray fine eyes; Solanaceae), *Physalis cinerascens* (smallflower groundcherry; Solanaceae), *Kallstroemia parviflora* (warty caltrop; Zygophyllaceae), *Aristida oligantha* (prairie threeawn; Poaceae), *A. purpurea* Nutt. (purple threeawn; Poaceae), *Chloris verticillata* (windmill grass; Poaceae), and *Hordeum pusillum* (little barley; Poaceae),

Although the surveyors provided no data regarding herbaceous plants, several of the exotic herbaceous species listed in table 2 were present in the United States prior to the 1870's. For example, *Tamarix ramosissima* (saltcedar, Tamaricaceae) was introduced as an ornamental to the United States in the early 19th century from Asia. Several life history traits of *Tamarix ramosissima,* and other members of this genus, facilitate their invasiveness. Saltcedars are known to grow from 9 to 12 feet in a year, can survive up to 70 days of immersion during flooding, and produce seeds constantly throughout the growing season (Invasivespecies.gov, 2005).

Likewise, *Sorghum halepense* (Johnsongrass, Poaceae), considered to be one of the ten worst weeds in the world, was introduced to North America from Mediterranean

Europe and Africa in the 1830's as a forage species (Holm et al. 1977). However, under stressful environmental conditions, such as drought, high temperature, or frost, *S. halepense* produces hydrocyanic acid which is toxic to cattle (Warwick and Black 1983). Since its introduction, *S. halepense* has become a major weed of disturbed areas in the United States.

Although *Kochia scoparia* (kochia, Chenopodiaceae) is a non-native, weedy species present at WBNHS, it is restricted to heavily disturbed areas in the Washita River floodplain. *Kochia scoparia* was introduced to the United States in the 19th century from eastern Russia. The intended useage was as an ornamental garden hedge (Forcella 1985). Although *K. scoparia* is no longer used in horticulture, it persists on the landscape as a noxious weed.

CONCLUSIONS

We recommend that WBNHS develop a long-term vegetation monitoring scheme in order to evaluate changes in vegetation composition and species diversity. Since the installation has initiated a burn program and is engaged in other management actions, a network of permanent plots is crucial for managers to evaluate the impact of these activities. Regular sampling of plots would also alert managers to any rapid change in the number and abundance of exotic plant species.

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Figure 1: Location of floristic collection sites at WBNHS.

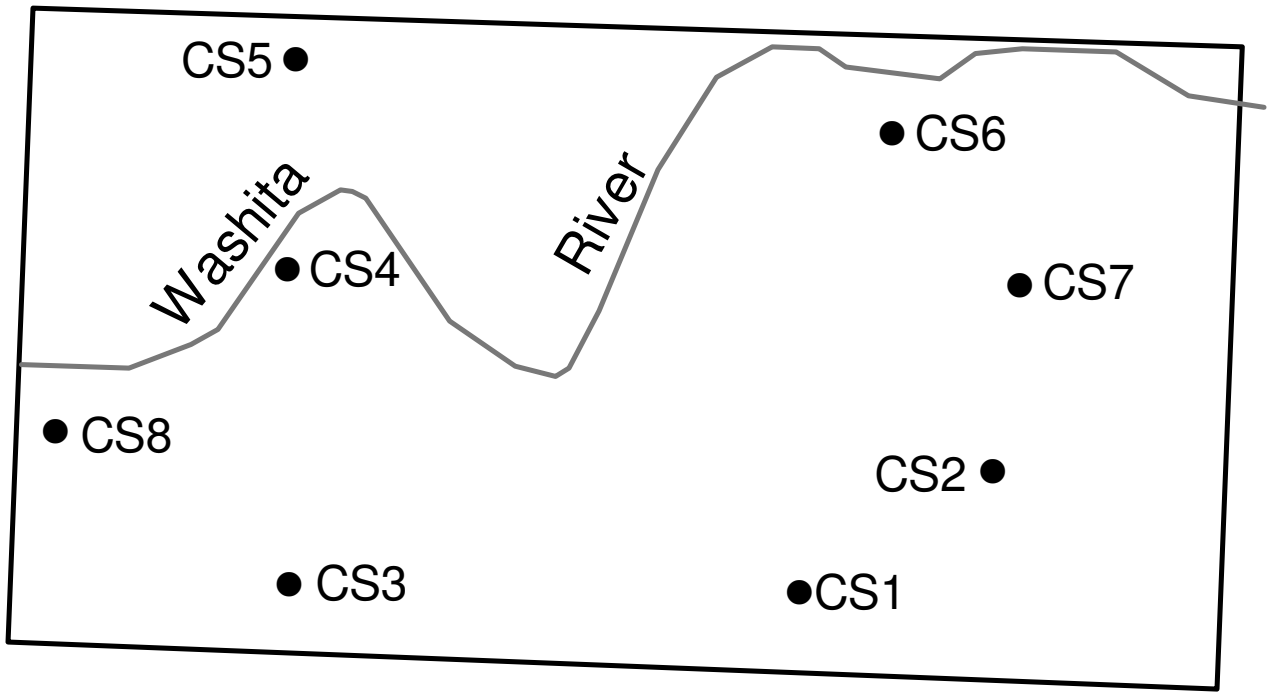

Figure 2: Historical vegetation of Roger Mills County and the Washita Battlefield National Historic Site.

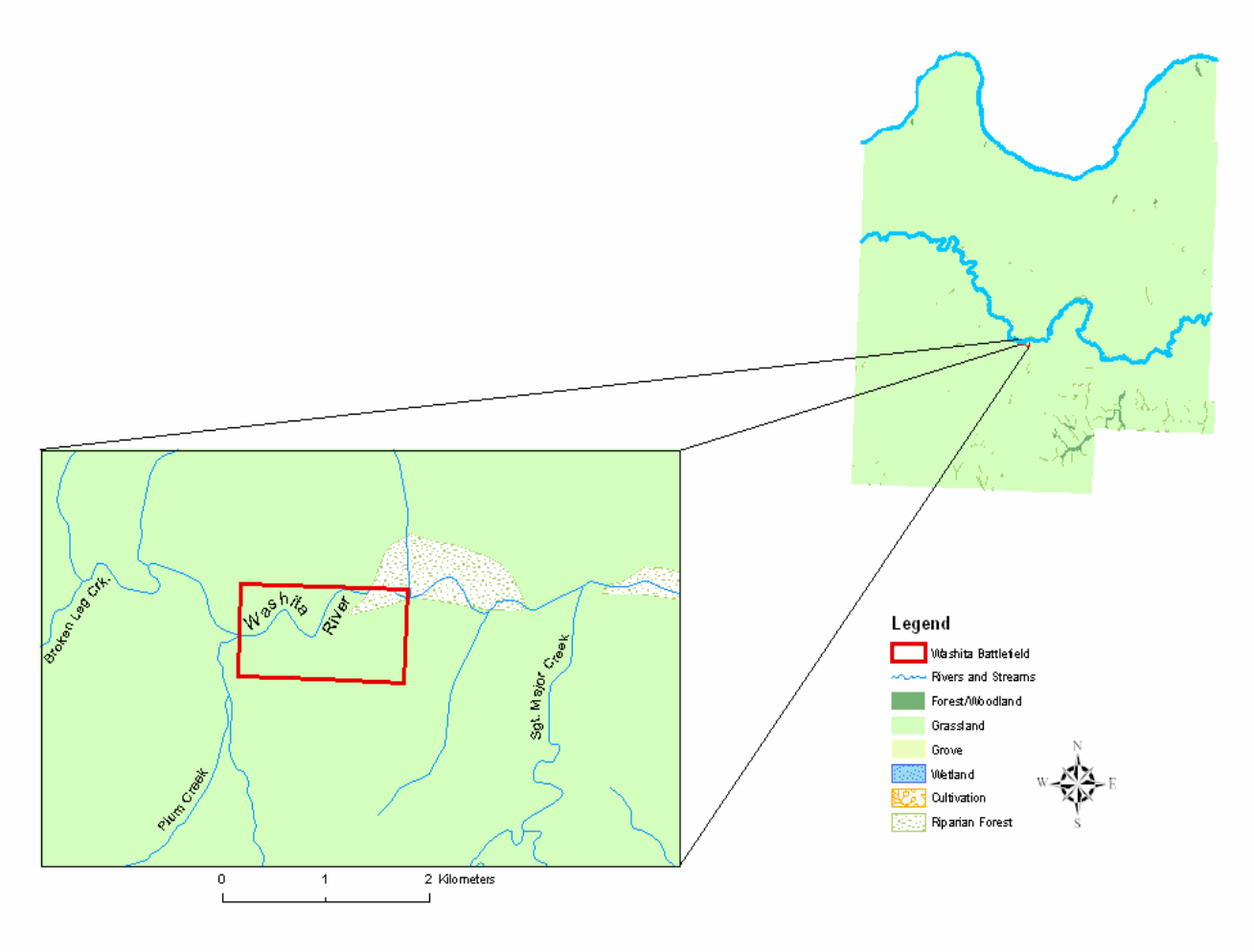

Table 1: Summary of floristic collections at the Washita Battlefield National Historic Site, Roger Mills County, Oklahoma. Table format follows Palmer et al. (1995).

Taxonomic Group	Species	Native spp.	Introduced spp.
Equisetophyta	0	0	0
Pteridophyta	0	0	0
Coniferophyta	1	1	0
Magnoliophyta			
Magnoliopsida	205	184	22
Liliopsida	67	56	10
Total	272	240	32

Table 2: Occurrence of exotic species in upland and riparian habitats at the Washita Battlefield National Historic Site.

Species	Upland	Riparian
Arenaria serpyllifolia	X	
Bothriochloa ischaemum	X	
Bromus japonicus	X	
Capsella bursa-pastoris	X	
Chenopodium album	X	
Convolvulus arvensis	X	
Cynodon dactylon	X	X
Echinochloa crus-galli		X
Eragrostis barrelieri	X	
Eragrostis cilianensis	X	
Eragrostis curvula	X	
Erodium cicutarium	X	
Geranium pusillum	X	
Hibiscus trionum		X
Kochia scoparia	X	
Lactuca serriola	X	
Lamium amplexicaule	X	
Lolium perenne	X	
Medicago minima	X	

Melilotus officinalis	X	X
Morus alba		X
Polygonum aviculare	X	X
Rumex crispus		X
Setaria viridis	X	
Sorghum halepense	X	X
Stellaria media	X	
Tamarix ramosissima		X
Taraxacum officinale	X	
Tragopogon dubius	X	X
Tribulus terrestris	X	
Triticum aestivum	X	X
Veronica arvensis	X	
Ulmus pumila		X

APPENDIX 1: Annotated species list for the Washita Battlefield National Historic Site. The first entry indicates growth form (F=forb, V=woody vine, S=shrub, T=tree), the second life history (A=annual, B=biennial, P=perennial), and the third, habitat type(DAOF=disturbed area/ old-field; MGP=mixed grass prairie; RA=riparian area; SW=sandy woodland). Species introduced to North America are denoted by an asterisks following the authority name. Voucher specimens were deposited at the Robert Bebb Herbarium at the University of Oklahoma (OKL).

PINOPHYTA

Cupressaceae

Juniperus virginiana L. (eastern redcedar): T; P; SW

MAGNOLIOPHYTA

MAGNOLIOPSIDA

Amaranthaceae

Amaranthus albus L. (prostrate pigweed): F; A; MGP

A. palmeri S. Wats. (carelessweed): F; A; DAOF

Froelichia gracilis (Hook.) Moq. (slender snakeroot): F; A; SW

Anacardiaceae

Rhus aromatica L. (fragrant sumac; skunkbrush): S; P; MGP

R. glabra L. (smooth sumac): S; P; MGP

Toxicodendron radicans (L.) Kuntze (eastern poison ivy): V; P; RA

Apiaceae

Chaerophyllum tainturieri Hook. (hairyfruit chervil): F; A; MGP

Cymopterus macrorhizus Buckl. (bigroot springparsley): F; P; MGP

Apocynaceae

Apocynum cannabinum L. (indianhemp): F; P; SW

Asclepiadaceae

Asclepias arenaria Torr. (sand milkweed): F; P; MGP, SW

A. asperula (Dcne.) Schlechter (spider milkweed): F; P; MGP

A. stenophylla Gray (slimleaf milkweed): F; P; MGP

A. syriaca L. (common milkweed): F; P; MGP

Funastrum cynanchoides (Dcne.) Schlechter (fringed twinevine): F; P; SW

Asteraceae

Ambrosia psilostachya DC. (western ragweed): F; P; MGP

A. trifida L. (gaint ragweed): F; A; MGP

Amphiachyris dracunculoides (DC.) Nutt. (broomweed): F; A; MGP

Aphanostephus skirrhobasis (DC.) Trel. (lazydaisy): F; A; MGP

Artemisia dracunculus L. (tarragon): F; P; MGP

A. filifolia Torr. (sandsage): S; P; MGP

A. ludoviciana Nutt. (white sage): F; P; MGP

Baccharis salicina Torr. & Gray (false willow): S; P; RA

Brickellia eupatorioides (L.) Shinners (false boneset): F; P; MGP

Chaetopappa ericoides (Torr.) Nesom (rose heath): F; P; MGP

Cirsium undulatum (Nutt.) Spreng. (wavyleaf thistle): F; P; MGP

Cirsium vulgare (Savi) Ten. (bull thistle): F; B; MGP

Conyza canadensis (L.) Cronq. (horseweed): F; A; DAOF

Eclipta prostrata (L.) L. (false daisy): F; A; RA

Engelmannia peristenia (Raf.) Goodman & Lawson (Engelmann's daisy): F; P; MGP

Erigeron bellidiastrum Nutt. (western daisy fleabane): F; A; MGP; SW

Eupatorium serotinum Michx. (lateflowering throughwort): F; P; RA

Euthamia gymnospermoides Greene (Texas goldentop): F; P; DAOF

Gaillardia pulchella Foug. (Indian blanket): F; A; MGP

G. suavis (Gray & Engelm.) Britt. & Rusby (perfumeballs): F; P; MGP

Grindelia papposa Nesom & Suh (Spanish gold): F; A; MGP

Helianthus annuus L. (annual sunflower): F; A; DAOF

H. maximiliani Schrad. (Maxmillian's sunflower): F; P; DAOF

H. petiolaris Nutt. (prairie sunflower): F; A; DAOF

Heterotheca subaxillaris (Lam.) Britt. & Rusby (camphorweed): F; A; MGP

H. villosa (Pursh) Shinners (hairy false goldenaster): F; P; MGP

Hymenopappus flavescens Gray (old plainsman): F; B; MGP

Iva annua L. (annual marshalder): F; P; DAOF; RA

Lactuca serriola L.* (prickly lettuce): F; A; MGP

Liatris pycnostachya Michx. (prairie blazing star): F; P; MGP

Lygodesmia juncea (Pursh) D. Don ex Hook. (skeletonweed): F; P; MGP

Machaeranthera pinnatifida (Hook.) Shinners (tansyaster): F; P; MGP

Pluchea odorata (L.) Cass. var. *odorata* (sweetscent): F; A; RA

Ratibida columnifera (Nutt.) Woot. & Standl. (prairie coneflower): F; P; MGP

Solidago canadensis L. (Canada goldenrod): F; P; DAOF

S. gigantea Ait. (giant goldenrod): F; P; DAOF

S. petiolaris Ait. (downy ragged goldenrod): F; P; MGP

Symphyotricum ericoides (L.) Nesom (white heath aster): F; P; DAOF

S. oblongifolium (Nutt.) Nesom (aromatic aster): F; P; MGP

S. subulatum (Michx.) Nesom (saltmarsh aster): F; A; RA

Taraxacum officinale G.H. Weber ex Wiggers* (dandelion): F; P; DAOF

Tetraneuris scaposa (DC.) Greene (four-nerve daisy): F; P; MGP

Thelesperma megapotamicum (Spreng.) Kuntze (greenthread): F; P; MGP

Tragopogon dubius Scop.* (yellow salsify): F; A; DAOF

Verbesina encelioides (Cav.) Benth. & Hook. f. ex Gray (golden crownbeard): F; A; DAOF

Vernonia baldwinii Torr. (Baldwin's ironweed): F; P; DAOF

Xanthium strumarium L. (cocklebur): F; A; RA

Zinnia grandiflora Nutt. (prairie zinnina): F; P; MGP

Boraginaceae

Helioitropium convolvulaceum (Nutt.) Gray (phlox heliotrope): F; A; SW

Lithospermum incisum Lehm. (narrowleaf stoneseed): F; P; MGP

Brassicaceae

Camelina rumelica Velen. (graceful false flax): F; A; MGP

Capsella bursa-pastoris (L.) Medik.* (shepherd's purse): F; A; DAOF

Descurainia pinnata (Walt.) Britt. (western tansyaster): F; A; MGP

Dimorphocarpa candicans (Raf.) Rollins (Palmer's spectacle pod): F; A; SW

Draba reptans (Lam.) Fern. (Carolina draba): F; A; MGP

Lepidium oblongum Small (veiny pepperweed): F; A; MGP

Lesquerella gordonii (Gray) S. Wats. (bladderpod): F; A; MGP

Cactaceae

Escobaria vivipara (Nutt.) Buxbaum (pincushion): F; P; MGP

Opuntia macrorhiza Engelm. (twistspine pricklypear): F; P; MGP

Campanulaceae

Triodanis holzingeri McVaugh (Venus looking-glass): F; A; MGP

Caryophyllaceae

Arenaria serpyllifolia L.* (thymeleaf sandwort): F; A; DAOF

Paronychia jamesii Torr. & Gray (James' nailwort): F; P; MGP

Stellaria media (L.) Vill.* (common chickweed): F; A; DAOF

Chenopodiaceae

Chenopodium album L.* (lambsquarter): F; A; MGP

C. simplex (Torr.) Raf. (mapleleaf goosefoot): F; A; MGP

Cycloloma atriplicifolium (Spreng.) Coult. (winged pigweed): F; A; MGP

Kochia scoparia (L.) Schrad.* (kochia): F; A; MGP

Convolvulaceae

Convolvulus arvensis L.* (field vineweed): F; P; MGP

Evolvulus nuttallianus J. A. Schultes (shuggy dwarf morning-glory): F; P; MGP

Ipomoea leptophylla Torr. (bush morning-glory): F; P; MGP

Cucurbitaceae

Cucurbita foetidissima Kunth (Missouri gourd): F; P; MGP

Cyclanthera dissecta (Torr. & Gray) Arn. (cutleaf cucumber): F; A; SW

Euphorbiaceae

Acalypha ostryifolia Riddell (threeseed mercury): F; A; MGP

Argythamnia humilis (Engelm. & Gray) Muell.-Arg. (low silverbush): F; P; MGP

Chamaesyce fendleri (Torr. & Gray) Small (Fendler's sandmat): F; P; MGP

C.glyptosperma (Engelm.) Small - (ribseed sandmat): F; A; MGP, SW

C. maculata (L.) Small (spotted sandmat): F; A; DAOF

C. missurica (Raf.) Shinners (prairie sandmat): F; A; MGP, DAOF

C. stictospora (Engelm.) Small (slimseed sandmat); A; DAOF

Croton glandulosus L. (vente conmigo): F; A; MGP

C. texensis (Klotzsch) Muell.-Arg. (Texas croton): F; A; MGP

Euphorbia dentata Michx. (toothed spurge): F; A; MGP

E. hexagona Nutt. ex Spreng. (six-angled spurge): F; A; MGP

E. longicruris Scheele (wedgeleaf spurge): F; A; MGP

E. marginata Pursh (snow on the mountain): F; A; DAOF

Tragia ramosa Torr. (branched noseburn): F; P; MGP

Fabaceae

Amorpha fruticosa L. (false indigo): S; P; RA

Astragalus lotiflorus Hook. (lotus milkvetch): F; P; MGP

A. plattensis Nutt. (Platte River milkvetch): F; P; MGP

Baptisia australis (L.) R. Br. ex Ait. f. (blue wild indigo): F; P; MGP

Caesalpinia jamesii (Torr. & Gray) Fisher (James holdback): F; P; SW

Cercis canadensis L. (redbud): T; P; DAOF

Chamaecrista fasciculata (Michx.) Greene (partridge pea): F; A; MGP

Dalea aurea Nutt. ex Pursh (golden prairie clover): F; P; MGP

D. candida Michx. ex Willd. (white prairie clover): F; P; MGP

D. enneandra Nutt. (nineanther prairie clover): F; P; MGP

D. purpurea Vent. (purple prairie clover): F; P; MGP

Desmodium illinoense Gray (Illinois ticktrefoil): F; P; MGP

Gleditsia triacanthos L. (honeylocust): T; P; SW

Gymnocladus dioicus (L.) K. Koch (Kentucky coffee tree): T; P; SW

Indigofera miniata Ortega (coastal indigo): F; P; SW

Medicago minima (L.) L.* (burr medick): F; A; DAOF

Melilotus officinalis (L.) Lam.* (yellow sweetclover): F; A; DAOF

Mimosa borealis Gray (fragrant mimosa): S; P; MGP

M. nuttallii (DC.) B.L. Turner (Nuttall's sensitive briar): V; P; MGP

Pediomelum linearifolium (Torr. & Gray) J. Grimes (narrowleaf breadroot): F; P; MGP

Sophora nuttalliana B.L. Turner (silky sophora): F; P; MGP

Strophostyles leiosperma (Torr. & Gray) Piper (slickseed fuzzybean): F; A; MGP

Fumariaceae

Corydalis micrantha (Engelm. ex Gray) Gray (smallflower fumewort): F; A; MGP

Geraniaceae

Erodium cicutarium (L.) L'Her. ex Ait.* (stork's bill): F; A; DAOF

Geranium pusillum L.* (small geranium): F; A; MGP

Grossulariaceae

Ribes aureum Pursh (golden currant): F; P; SW

Juglandaceae

Juglans microcarpa Berl. (little walnut): T; P; SW

Krameriaceae

Krameria lanceolata Torr. (trailing krameria): F; P; MGP

Lamiaceae

Lamium amplexicaule L.* (henbit): F; A; DAOF

Lycopus americanus Muhl. ex W. Bart. (water horehound): F; P; RA

Monarda clinopodioides Gray (basil beebalm): F; A; MGP

M. punctata L. (spotted beebalm): F; A; MGP

Salvia azurea Michx. ex Lam. (azure sage): F; P; MGP

Scutellaria resinosa Torr. (sticky skullcap): F; P; MGP

S. wrightii Gray (Wright's skullcap): F; P; MGP

Teurcium canadense L. (Canada germander): F; P; RA

T. laciniatum Torr. (lacy germander): F; P; MGP

Linaceae

Linum pratense (J.B.S. Norton) Small (meadow flax): F; A; MGP

L. rigidum Pursh (stiffstem flax): F; A; MGP

Loasaceae

Mentzelia nuda (Pursh) Torr. & Gray (bractless sand lily): F; P; MGP

Lythraceae

Ammania coccinea Rottb. (redstem): F; A; RA

Malvaceae

Callirhoe involucrata (Torr. & Gray) Gray (purple poppymallow): F; P; MGP

Hibiscus trionum L.* (flower of an hour): F; P; MGP

Sphaeralcea coccinea (Nutt.) Rydb. (scarlet globemallow): F; P; MGP

Menispermaceae

Cocculus carolinus (L.) DC. (Carolina snailseed): F; P; SW

Molluginaceae

Mollugo verticillata L. (green carpetweed): F; A; DAOF; SW

Moraceae

Morus alba L.* (white mulberry): T; P; DAOF

Nyctaginaceae

Mirabilis albida (Walt.) Heimerl (white four o'clock): F; P; MGP

M. linearis (Pursh) Heimerl (narrowleaf four o'clock): F; P; MGP

M. nyctaginea (Michx.) MacM. (heartleaf four o'clock): F; P; MGP; SW

Oleaceae

Forestiera pubescens Nutt. (elbowbush): S; P; SW

Onagraceae

Calylophus berlandieri Spach (Berlander's sundrops): F; P; MGP

C. hartwegii (Benth.) Raven (Hartweg's sundrop): F; P; MGP

C. serrulatus (Nutt.) Raven (yellow sundrops): F; P; MGP

Gaura brachycarpa Small (plains beeblossom): F; A; MGP

G. parviflora Dougl. ex Lehm. (velvetweed): F; A; MGP

Oenothera jamesii Torr. & Gray (trumpet evening-primrose): F; P; RA

O. laciniata Hill (cutleaf evening-primrose): F; P; MGP

O. rhombipetala Nutt. ex Torr. & Gray (fourpoint evening-primrose): F; P; MGP

Oxalidaceae

Oxalis stricta L. (yellow sorrell): F; P; SW

Papaveraceae

Argemone polyanthemos (Fedde) G.B. Ownbey (pricklypoppy): F; A; SW

Pedaliaceae

Proboscidea louisianica (P. Mill.) Thellung (ram's horn): F; A; MGP

Plantaginaceae

Plantago patagonica Jacq. (wooly plantain): F; A; MGP

P. rhodosperma Dcne. (redseed plantain): F; A; MGP

Polygonaceae

Eriogonum annuum Nutt. (annual buckwheat): F; A; DAOF; MGP

E. longifolium Nutt. (lonfleaf buckwheat): F; P; MGP

Polygonum aviculare L.* (prostrate knotweed): F; A; MGP

P. lapathifolium L. (curlytop knotweed): F; A; RA

Rumex crispus L.* (curly dock): F; P; MGP

Portulacaceae

Portulaca oleracea L. (little hogweed): F; A; DAOF

Primulaceae

Androsace occidentalis Pursh (western rockjasmine): F; A; MGP

Ranunculaceae

Delphinium carolinianum Walt. ssp. *virescens (*Nutt.) Brooks (Carolina larkspur): F; P; MGP

Rosaceae

Prunus angustifolia Mars. (sand plum): S; P; SW

Rubiaceae

Cephalanthus occidentalis L. (buttonbush): S; P; RA

Galium pilosum Ait. (hairy bedstraw): F; P; DAOF

Hedyotis nigricans (Lam.) Fosberg (diamondflowers): F; P; MGP

Salicaceae

Populus deltoides Bartr. ex Marsh. (eastern cottonwood): T; P; RA

Salix exigua Nutt. (sandbar willow): S; P; RA

S. nigra Marsh. (black willow): S; P; RA

Sapindaceae

Sapindus saponaria L. (soapberry): T; P; SW

Sapotaceae

Sideroxylon lanuginosum Michx. (gumbully): T; P; SW

Scrophulariaceae

Castilleja purpurea (Nutt.) G. Don var. *citrina* (Pennell) Shinners (downy Indian paintbrush): F; P; MGP

Penstemon albidus Nutt. (white penstemon): F; P; MGP

Veronica arvensis L.* (corn speedwel): F; A; DAOF

Solanceae

Chamaesaracha conioides (Moric. ex Dunal) Britt. (gray fine eyes): F; P; MGP

Physalis cinerascens (Dunal) A.S. Hitchc. (smallflower groundcherry): F; P; MGP

P. longifolia Nutt. (longleaf graoundcherry): F; P; MGP

Quincula lobata (Torr.) Raf. (Chinese lantern): F; P; DAOF

Solanum dimidiatum Raf. (western horsenettle): F; P; DAOF

S. elaeagnifolium Cav. (silverleaf nightshade): F; P; DAOF; MGP

S. rostratum Dunal (buffalobur): F; A; DAOF; MGP

S. triflorum Nutt. (cutleaf nightshade): F; A; MGP

Tamaricaceae

Tamarix ramosissima Ledeb.* (saltcedar): S; P; RA

Ulmaceae

Celtis laevigata Willd. var. *reticulata* (Torr.) L. Benson (netleaf hackberry): T; P; SW

Ulmus pumila L.* (Siberian elm): T; P; SW

U. rubra Muhl. (red elm): T; P; SW

Urticaceae

Parietaria pensylvanica Muhl. ex Willd. (Pennsylvania pellitory): F; A; DAOF; SW

Verbenaceae

Glandularia pumila (Rydb.) Umber (pink mock vervain): F; A; DAOF; MGP

Phyla lanceolata (Michx.) Greene (lanceleaf frogfruit): F; P; RA

Violaceae

Hybanthus verticillatus (Ortega) Baill. (babyslippers): F; P; MGP

Vitaceae

Ampelopsis cordata Michx. (heartleaf peppervine): V; P; RA

Cissus incisa auct. non Des Moulins (possum grape): V; P; SW

Vitis acerifolia Raf. (mapleleaf grape): V; P; RA

Zygophyllaceae

Kallstroemia parviflora J.B.S. Norton (warty caltrop): F; A; DAOF

Tribulus terrestris L.* (puncturevine): F; A; DAOF

LILIOPSIDA

Agavaceae

Yucca glauca Nutt. (soapweed): S; P; MGP

Commelinaceae

Commelina erecta L. (whitemouth dayflower): F; P; MGP

Tradescantia occidentalis (Britt.) Symth (prairie spiderwort): F; P; MGP

Cyperaceae

Carex gravida Bailey (heavy sedge): F; P; MGP

Cyperus odoratus L. (lean flatsedge): F; A; MGP

C. schweinitzii Torr. (Schweinitz's flatsedge): F; P; MGP

C. setigerus Torr. & Hook. (lean flatsedge): F; P; RA

Fimbristylis vahlii (Lam.) Link (Vahl's fimbry): F; A; RA

Schoenoplectus pungens (Vahl) Pall (threesquare bulrush): F; P; RA

Iridaceae

Sisyrinchium angustifolium P. Mill. (blue-eyed grass): F; P; MGP

Juncaceae

Juncus torreyi Coville (Torrey's rush): F; P; RA

Liliaceae

Allium canadense L. (meadow garlic): F; P; MGP

A. drummondii Regel (Drummond's onion): F; P; MGP

Poaceae

Andropogon hallii Hack. (sand bluestem): F; P; MGP; SW

Aristida oligantha Michx. (prairie threeawn): F; A; MGP

A. purpurea Nutt. (purple threeawn): F; P; MGP

Bothriochloa ischaemum (L.) Keng* (old world bluestem): P; MGP

B. laguroides (DC.) Herter (silver bluestem): F; P; MGP

Bouteloua curtipendula (Michx.) Torr. (sideoats grama): F; P; MGP

B. gracilis (Willd. ex Kunth) Lag. ex Griffiths (blue grama): F; P; DAOF; MGP

B. hirsuta Lag. (hairy grama): F; P; MGP

Bromus japonicus Thunb. ex Murr.* (Japanese brome): F; A; DAOF; SW

Buchloe dactyloides (Nutt.) Engelm. (buffalograss): F; P; DAOF; MGP

Cenchrus spinifex Cav. (coastal sandbur): F; P; SW

Chloris verticillata Nutt. (windmill grass): F; P; DAOF; MGP

Cynodon dactylon (L.) Pers.* (bermudagrass); F; P; DAOF

Dichanthelium malacophyllum (Nash) Gould (softleaf rosette grass): F; P; MGP

D. oligosanthes (J.A. Schultes) Gould (Heller's rosette grass): F; P; MGP

Digitaria ciliaris (Retz.) Koel. (southern crabgrass); F; P; DAOF

D. cognata (J.A. Schultes) Pilger (Carolina crabgrass): F; P; MGP

Distichlis spicata (L.) Greene (saltgrass); F; P; DAOF

Echinochloa crus-galli (L.) Beauv.* (barnyard grass): F; A; RA

Elymus canadensis L. (Canadian wildrye): F; P; MGP

E. virginicus L. (Virginia wildrye): F; P; RA

Eragrostis barrelieri Daveau* (Mediterranean lovegrass): F; A; DAOF

E. cilianensis (All.) Vign. ex Janchen* (stinkgrass): F; A; DAOF

E. curvula (Schrad.) Nees* (weeping lovegrass): F; P; MGP

E. spectabilis (Pursh) Steud. (purple lovegrass); F; P; SW

Erioneuron pilosum (Buckl.) Nash (woolygrass): F; P; MGP

Hordeum pusillum Nutt. (little barley): F; A; DAOF

Leptochloa fusca (L.) Kunth ssp. *fasicularis* (Lam.) N. Snow (bearded spangletop): F; A; RA

Lolium perenne L.* (perennial ryegrass): F; P; MGP

Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi (scratchgrass): F; P; SW

M. racemosa (Michx.) B.S.P. (marsh muhly): F; P; MGP

M. sobolifera (Muhl. ex Willd.) Trin. (rock muhly): F; P; MGP

Panicum capillare L. (witchgrass): F; A; MGP

P. obtusum Kunth (vine mesquite): F; P; MGP; RA

P. virgatum L. (switchgrass): F; P; MGP

Pascopyrum smithii (Rydb.) A. Love (western wheatgrass): F; P; MGP

Paspalum setaceum Michx. (thin paspalum): F; P; DAOF

Poa arachnifera Torr. (Texas bluegrass); F; P; RA

Saccharum giganteum (Walt.) Pers. (sugarcane plumegrass): F; P; RA

Schedonnardus paniculatus (Nutt.) Trel. (tumblegrass): F; P; DAOF

Schizachyrium scoparium (Michx.) Nash (little bluestem): F; P; MGP

Setaria parviflora (Poir.) Kerguelen (marsh bristlegrass): F; P; DAOF

S. viridis (L.) Beauv.* (green bristlegrass): F; A; MGP

Sorghastrum nutans (L.) Nash (Indiangrass): F; P; MGP

Sorghum halepense (L.) Pers.* (Johnsongrass): F; P; DAOF

Spartina pectinata Bosc ex Link (prairie cordgrass): F; P; RA

Sporobolus cryptandrus (Torr.) Gray (sand dropseed): F; P; MGP, SW

S. giganteus Nash (giant dropseed): F; P; MGP

S. vaginiflorus (Torr. ex Gray) Wood (poverty dropseed): F; A; SW

Tridens flavus (L.) A.S. Hitchc. (purpletop): F; P; DAOF

Triplasis purpurea (Walt.) Chapman (purple sandgrass): F; A; MGP

Triticum aestivum L.* (wheat): F; A; DAOF

Vulpia octoflora (Walt.) Rydb. (sixweeks fescue): F; A; MGP

APPENDIX 2: Diameter and distance measures of trees species recorded by surveyors at the Washita Battlefield National Historic Site.

Surveyor identification	attributed binomial	diameter	distance
Cottonwood	*Populus deltoides*	18 inches	183 feet
Cottonwood	*Populus deltoides*	24 inches	58 feet